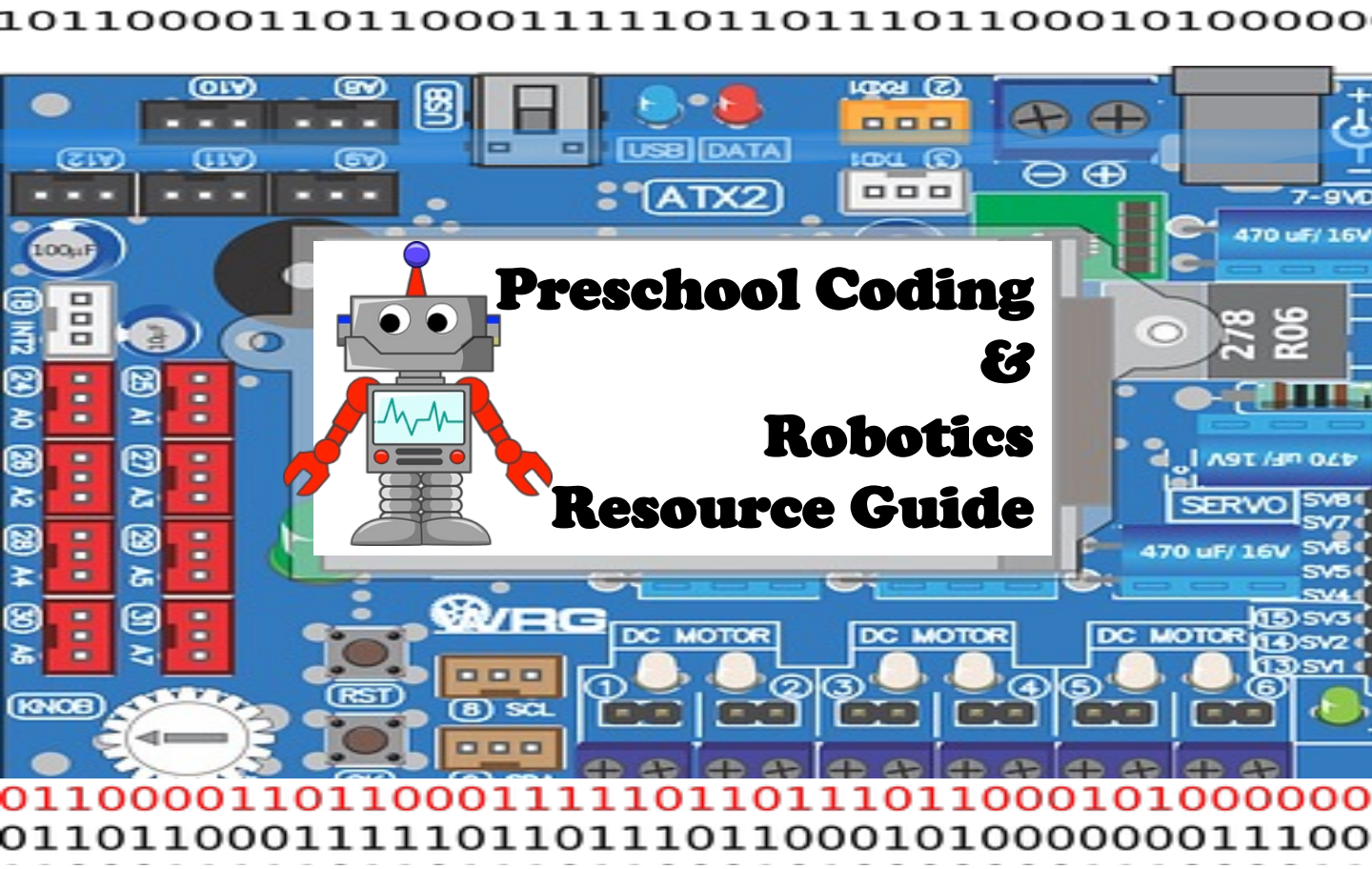

Tap into children's natural curiosity and explore the world of preschool coding and robotics!

Teach children how to use problem solving skills, explore cause and effect, and critical thinking to develop programming skills through age-appropriate coding and robotic learning strategies.

Dr. Theresa Vadala

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Preschool Coding & Robotics Resource Book

by

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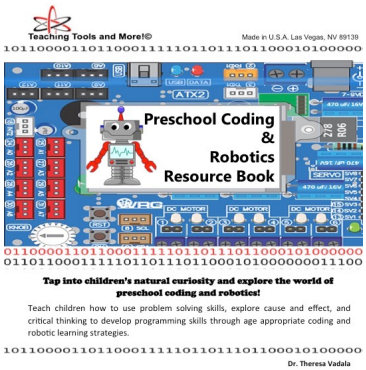
Las Vegas, Nevada 89139



Limits of Liability and Disclaimer of Warranty

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Goal

The goal of the **Preschool Coding & Robotics** Resource Book is to provide current research-based learning strategies for teachers to integrate in daily teaching practices. These strategies for learners help connect new learning concepts to prior learning, provide early childhood educators with a wide range of STEM (Science, Technology, Engineering, and Mathematics) based activities, lesson plan ideas for teachers to teach children to actively explore, investigate, observe and learn how to problem solve, locally, nationally, and globally.

About Us

Theresa Vadala, Ed. D. has over 35 years experience in the field of early childhood education. She is a Business Owner, Professional Development Trainer and Curriculum Designer. She develops curriculum to reach the early childhood providers locally and globally.

Business Description

The primary goal of Teaching Tools and More Educational Company is to provide early childhood educators with effective STEM-based (Science, Technology, Engineering, Mathematics) resources complete with objective-based lesson plans, instructions, and materials that help children communicate, make connections, take on challenges, ask questions, and think critically in everyday learning experiences.

Preschool Coding & Robotics

Objectives:

Learners will be able to…

Part 1:

1) Explain why teaching coding and robotics are important skills to learn at an early age.

Part 2:

2) Engage in activities that promote creative thinking skills and manipulate a variety of materials to create and assemble a robot.

Part 3:

3) Apply age-appropriate coding and robotic strategies in everyday teaching strategies.

Number games help develop computer programming skills. All types of math games in everyday play are crucial life skills. Math concepts are used daily when we check the time, schedules, routines or going grocery shopping. Counting, addition and subtraction, measurement, data analysis, and geometry skills are used daily in children's learning experiences. Activities on color sorting, sequencing, patterns, graphing, identifying shapes, and comparing differences and similarities are part of number sense. All these activities provide children with coding skills.

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Contents

Objective/s

Learners will be able to…

1) Explain why teaching coding and robotics are important skills to learn at an early age.

Provider's Guide

Part 1: History of Robots & Coding

- Introduction
- Brief History of Robots
- Robotics in Today's Digital Age
- Coding
- Binary Coding
- Why Teach Binary Coding to Preschoolers
- Binary Alphabet and Number Coding
- Barcodes

Part 1: Preschool Robotics & Coding

Introduction

Research shows that young children can learn programming and engineering at an early age. When children are given age-appropriate tools to incorporate in their daily learning activities, children engage more in open-ended play, integration of technology skills, expressive arts, culturally diverse activities, math and language activities. Children learn best when using a wide variety of materials and manipulates to choose from. Children are more apt to problem solve, explore cause and effect, sequence and figure out things on their own. Provide children with a wide range of open-ended activities and children's minds will flourish!

Brief History of Robotics

In the first century A.D., Petronius Arbiter made a doll that could move like a human being. In 1557, Giovanni Torriani created a wooden robot that could fetch the Emperor's daily bread from the store. Robotic inventions reached a peak in the 1700s; countless ingenious robots were created during this time period. The 19th century was also filled with new robotic creations such as a steam-powered robot made by Canadians. Although these inventions throughout history have not gone without notice, the scientific progress made in the 20th century in the field of robotics by far surpasses any previous advancements in robotics.

Robotics in Today's Digital Age

Robots today fulfill a variety of tasks. Robots today perform labor tasks for humans. Robots are used in the automotive industry to assemble part, in space exploration to explore the surfaces of the moon or to repair space equipment. In the medical industry, robots perform surgery that may be too delicate for a surgeon's hand to do. Toy robots and electronic dog robots are used for fun or for robot enthusiast. Robots are used in manufacturing processes or jobs which are dangerous for humans.

Robotics is a mechanical device that can be programmed to follow specific instructions. The benefits from teaching children robotics are to teach team-building skills, enhanced creating thinking skills, problem solving skills social skills and computer programming skills. Robotic activities increase creativity, teach children to follow directions, and a sense of accomplishment when a project is completed.

Robots can be creatively made with household items: cereal boxes, can, water bottles, blocks, paper rolls, nut and bolts, egg cartons, and just about any type of recyclable materials.

Coding, robotics, and engineering are becoming a fad for the future. Integrating robotics into the early childhood education helps introduce STEM concepts, an exploration of science, technology, engineering and math. Incorporating these ideas in an age-appropriate manner, children are engaging in playful learning that cultivates their curiosity in this digital age of computer programming.

Coding

What is coding? We use coding skills daily. It is an integral part of our everyday lives. When we use our computers, phones, the TV, use credit cards, we are using coding skills. Coding is the computer language used to develop apps, website and software. Phones have a code for log in security. Television coding is used to block profanity from children's television shows. Credit cards companies use coding for security purposes. Every item in a store has a specific code for identifying the item and pricing.

Coding requires problem solving skills, learning to work both independently and in a collaborative group. Coding also shows initiative, organizational skills, and responsibility. Coding requires asking questions, science concepts, math and language skills.

In this digital age, coding activities can set the foundation for students to think like a computer programmer. Children learn at all different levels and simple, age-appropriate coding activities help students at their current level and help them to expand their mind through creativity.

List other items that use coding:

_____

_____

_____

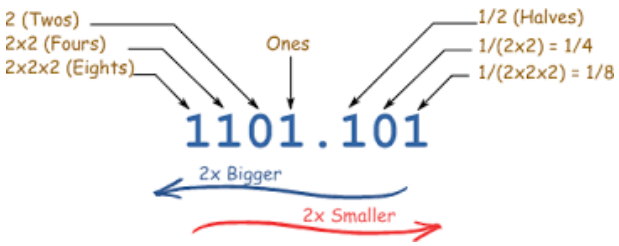
_____

_____

_____

Binary Coding

The Binary number system is an alternative to the decimal (10-base) number system that we use daily. The binary number system is is used to write data such as instructions for digital text or computer processors use. Data in a computer is stored and transmitted as a series of zeros and ones. Every eight digits represents a capital or lowercase letter. Numbers have a series of six zeros and ones.




```
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11000011011000111110110111011000101000000011100
01100011111011011101100010100000001110000110001
00011011000111110110111011000101000000011100001
01100001101100011111101101110110001010000000111O
01101100011111011011101100010100000001110000110
11000111110110111011000101000000011100001100011
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00101100001101100011111011011101100010100000001
10000110110001111101101110110001010000000111000
11000111110110111011000101000000011100001100011
00110110001111101101110110001010000000111000011
```

Why Teach Binary Coding to Preschoolers

Today's preschoolers are digital natives. They were born into a digital world. A life filled with technology; phones, computers, and tablets. Providing age appropriate activities, preschoolers can explore the beginning concepts of coding. Coding activities help children learn how technology works, understand robotics, and how to use critical thinking skills.

Binary Alphabet

A	01000001	N	01001110	a	01100001	n	01101110
B	01000010	O	01001111	b	01100010	o	01101111
C	01000011	P	01010000	c	01100011	p	01110000
D	01000100	Q	01010001	d	01100100	q	01110001
E	01000101	R	01010010	e	01100101	r	01110010
F	01000110	S	01010011	f	01100110	s	01110011
G	01000111	T	01010100	g	01100111	t	01110100
H	01001000	U	01010101	h	01101000	u	01110101
I	01001001	V	01010110	i	01101001	v	01110110
J	01001010	W	01010111	j	01101010	w	01110111
K	01001011	X	01011000	k	01101011	x	01111000
L	01001100	Y	01011001	l	01101100	y	01111001
M	01001101	Z	01011010	m	01101101	z	01111010

Start by writing your name in binary code.
(Example: **Cat** = **01000011011000001110100)**

Write you name in the space below in Binary Alphabet Code.

_____

_____

Binary Numbers

Number	Binary equivalent
0	000000
1	000001
2	000010
3	000011
4	000100
5	000101
6	000110
7	000111
8	001000
9	001001
10	001010
11	001011
12	001100
13	001101
14	001110
15	001111

Write your phone number in binary code.
(Example: 7028372434 =
0001110000000000010010000000110001110000 10
7 0 2 8 3 7 2

0001000000110001004 3 4

Write your phone number in Binary Number Code.

_____

_____

_____

Barcodes

A barcode symbol is a machine-readable image which conveys data. Barcodes are divided into three general types; Linear, Stacked linear, and two-dimensional Linear. Barcodes children may be most familiar with are Postal Barcode, QR Code, and UPC code.

Postal barcodes typically consists of the zip code and delivery points. The Intelligent Mail Barcode system is replacing the Post net system for routing mail by the USPS. The barcode consist of 65-bar variable-height code with four types of bars.

The UPC is the standard retail "Price Code" barcode in the United States. The digits on the left side of the barcode identify the manufacturer. The five digits are the product code which are determined by the manufacturer.

The QR (Quick Response) Code format was designed by the Japanese Automotive Industry to keep track of cars on the assembly line and car parts. It has become widely used in a variety of consumer-oriented application and in a variety of industries become of its versatility.

Barcodes and Robotics

Barcodes are found on every item a consumer purchases. Some robotic capabilities include reading barcodes. The QR scan code may be found on students work that directs them to a video. Barcodes are widely use in everyday living experiences. Children at one time or another have seen various barcodes. Learning about barcodes is part of computer programming. The code has been programmed and the consumer (you) are the computer. The scanner is the robot reading the programmed information.

Objective/s

Learners will be able to…

2) Engage in activities that promote creative thinking skills and manipulate a variety of materials to create and assemble a robot.

Provider's Guide

Part 2: Coding & Robot Activities using Loose Parts

- Code Hunter Activity
- Egg Carton Coding Activity
- Chalk Block Coding Activity
- Cup Stacking Coding Activity
- Binary Code Name
- Binary Code Bracelet
- Maze Runner "Developing Resilience" Activity
- Building Block "Debugging" Activity
- Nuts and Bolts of a Robot
- Build-a-Box Robot
- Loose Parts Robot
- Robotic Hand Activity

Part 2: Coding & Robot Lessons using Loose Parts

Introduction

Research shows that incorporating loose parts into a play environment broadens the opportunities for various types of play, including creative, exploratory, dramatic, cooperative, and constructive play. Studies indicated that children prefer to play in areas where loose parts are provided as loose parts tend to promote more creative ways of thinking, encourage exploration of the environment, and stimulate a variety of movements.

Loose parts sparks infinite play possibilities. *Loose parts* are synthetic, found, natural, new, or recycled materials. Children have opportunities to create, manipulate, control or change their play. Including **loose parts** in an environment empower children with their social skills and creativity. When planning to use loose parts with children, plan by adding a small amount so they are not overwhelmed with to many options. Materials may be added in time once children adapt to their abilities and expand their creations. Using loose parts allows for children to use critical thinking skills, create, and invent at their own pace.

Loose part materials allow for all students to be included in the same activity and with different outcomes. Children will have opportunities to ask questions and be creative, as well as follow directions. All the activities combined are carefully selected to teach age-appropriate computer programming skills at a very young age!

Code Hunting Activity

Children will follow verbal instructions to hunt for the "Code." This teaches children Algorithms; a process of set of rules to be followed. This is a skill computer programmers use when coding.

Objective:

Learners will be able to recognize "Robot Commands" to hunt for the "Code" located in the classroom given verbal instructions.

Preparations and Materials:

Write a 3-digit binary code on a card. Place the card somewhere in the classroom. Give verbal "Robot Commands" to locate the Code. Once the Code is found, ask student to use the binary code chart to decode.

Instructions:

- Decide which code student will hunt
- Create a map of where the code will be hidden
- The teacher/student will use the map to give verbal commands.

Robot Commands

- **Step Right**
- **Step Left**
- **Step Forward**
- **Step Backwards**

Coding Example:

Variations:

Place a variety of similar items on a tray. Use verbal directions to describe the items you want student to select.

Egg Carton Coding Activity

Coding activities help children develop perseverance. Children will try again if they land on an egg that does not contain the "surprise." This is referred to as debugging (identifying and removing errors).

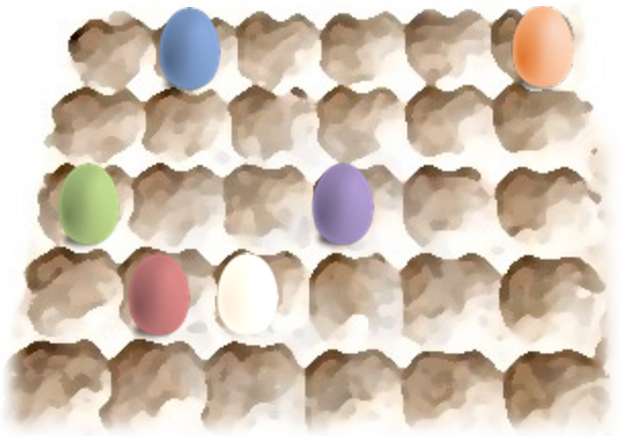
Objective:
Learners will be able to follow an algorithm (set of instructions) in order to choose the plastic egg containing the "surprise" inside.

Preparations and Materials:
- Egg carton from flat of eggs
- Plastic eggs/variety of colors
- Make a set of Instruction Cards (Write commands of your choice)
- Surprise for egg (sticker, toy surprise, etc.)

Instructions:
Place plastic eggs in random positions in egg carton. Use cards with verbal instructions and read to students. The goal is to reach a specific egg with a "surprise" inside. If you land on a space containing an egg, you must open the egg and follow the instructions. Remove the egg from the carton and continue the game until the surprise egg is found.

Instruction Cards

- Move the blue egg two spaces to the right
- Move the green egg three spaces to forward
- Move the red egg one space to the left
- Move the white egg three spaces backwards.



Variations:
Place math equations, codes, words, or movement commands in the eggs.

Chalk Block Coding Activity

Students will learn about how to code, algorithms, sequencing, and debugging.

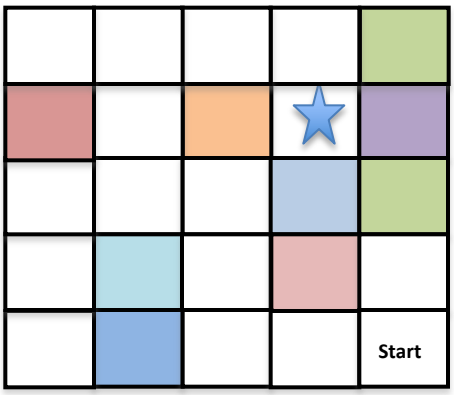
Objective:
Learners will be able demonstrate understanding of verbal instruction to reach the square with the star.

Materials:
Chalk

Instructions:.
Draw a large grid with 25 squares outdoors in the playground. Shade in random squares with chalk. Draw a star on one square. The goal is to verbally direct a student to square with the star. Student must face forward through the duration of the activity.

Types of Commands

- **Take 2 Steps Left**
- **Take 2 Steps Forward**
- **Take 2 Steps Forward**
- **Take 2 Steps Right**
- **Take 1 Step Backwards**



Variations: Use yarn or tape to design the grid. Write a number or letter in squares. Write a binary code in a square with the star for student to decode when reached.

Cup Stacking Coding Activity

Robots need clear instruction to understand and follow. Build a tower by following robot command cards.

Objectives:

Learners will be able to construct a tower with plastic cups by following robot command symbols.

Materials:

Plastic cups, Cards with cup symbols

Instructions:

Build a tower using robot command codes. After the tower has been built, compare the tower to the card symbol. If it is incorrect... TRY Again!

Robot Command Codes:

0 0 0 ⬆⬇ ⬅ ⬆⬇ ➡ ⬆⬇

Robot Command Codes

Pick up cup ⬆

Put down cup ⬇

Move cup right ➡

Move cup left ⬅

0 = Base Cups/Bottom

Robot Command Symbol

Variations: Create additional robot commands symbols by combining existing symbols.
Pick up and put down cup. Upside Down =

Binary Code Name Activity

Binary code can be represented by any two symbols, such as 1s or 0s or two different colors. Students will learn coding and decoding skills by practicing how to write the letters of their name.

Objective:
Learners will be able to code their name by using the binary code chart.

Materials:
Binary Code Chart
Name Tags/Labels

Instructions:
Use the binary code chart to decode your name.

HELLO!
01010100
01101111
01101101
(Tom)

Variations: Write your phone number in binary code. Create codes on cards and have students decode.

Binary Code Charts

A	01000001
B	01000010
C	01000011
D	01000100
E	01000101
F	01000110
G	01000111
H	01001000
I	01001001
J	01001010
K	01001011
L	01001100
M	01001101

N	01001110
O	01001111
P	01010000
Q	01010001
R	01010010
S	01010011
T	01010100
U	01010101
V	01010110
W	01010111
X	01011000
Y	01011001
Z	01011010

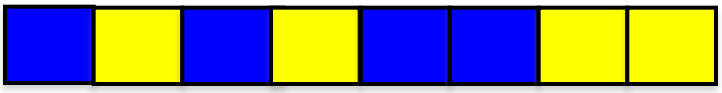
a	01100001
b	01100010
c	01100011
d	01100100
e	01100101
f	01100110
g	01100111
h	01101000
i	01101001
j	01101010
k	01101011
l	01101100
m	01101101

n	01101110
o	01101111
p	01110000
q	01110001
r	01110010
s	01110011
t	01110100
u	01110101
v	01110110
w	01110111
x	01111000
y	01111001
z	01111010

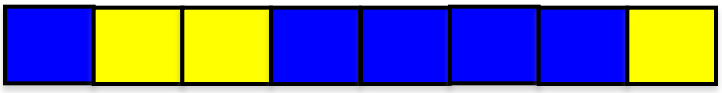
Binary Code Name Activity

A	■□■■	■■■□	N	■□■■	□□□■
B	■□■■	■■□■	O	■□■■	□□□□
C	■□■■	■■□□	P	■□■□	■■■■
D	■□■■	■□■■	Q	■□■□	■■■□
E	■□■■	■□■□	R	■□■□	■■□■
F	■□■■	■□□■	S	■□■□	■■□□
G	■□■■	■□□□	T	■□■□	■□■■
H	■□■■	□■■■	U	■□■□	■□■□
I	■□■■	□■■□	V	■□■□	■□□■
J	■□■■	□■□■	W	■□■□	■□□□
K	■□■■	□■□□	X	■□■□	□■■■
L	■□■■	□□■■	Y	■□■□	□■■□
M	■□■■	□□■□	Z	■□■□	□■□■

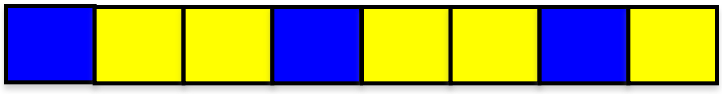
C = 0 1 0 1 0 0 1 1



A = 0 1 1 0 0 0 0 1



T = 0 1 1 0 1 1 0 1



Variations: Write your phone number in binary code. Create codes on cards and have students decode.

Binary Code Bracelet Activity

Providing age-appropriate activities, preschoolers can explore the beginning concepts of coding. Coding activities help children learn how technology works, understand robotics, and how to use critical thinking skills.

Objective:

Learners will be able to decode the letters of their first and last name to create a binary code bracelet.

Materials:

Binary Decode Chart

Beads (2 Colors – a third color can be used for spaces)

Bracelet String

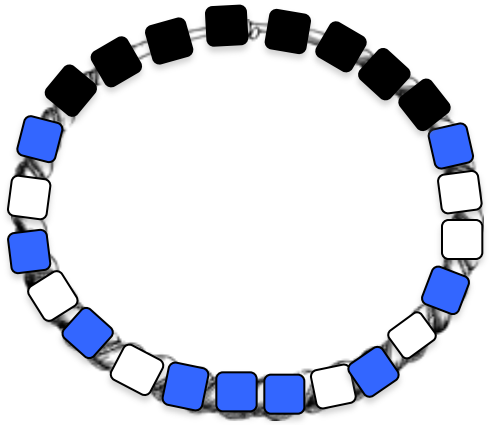
Instructions:

Find the first letter of your first name and the first letter of your last name. Find the bead color that matches the code. Start stringing the binary code bracelet with the matching beads.

Binary Decoder Key

A	■□■■	■■■□	N	■□■■	□□□■
B	■□■■	■■□■	O	■□■■	□□□□
C	■□■■	■■□□	P	■□■□	■■■■
D	■□■■	■□■■	Q	■□■□	■■■□
E	■□■■	■□■□	R	■□■□	■■□■
F	■□■■	■□□■	S	■□■□	■■□□
G	■□■■	■□□□	T	■□■□	■□■■
H	■□■■	□■■■	U	■□■□	■□■□
I	■□■■	□■■□	V	■□■□	■□□■
J	■□■■	□■□■	W	■□■□	■□□□
K	■□■■	□■□□	X	■□■□	□■■■
L	■□■■	□□■■	Y	■□■□	□■■□
M	■□■■	□□■□	Z	■□■□	□■□■

Binary Code Bracelet



TV =

Variations: Use pipe cleaners with beads to make a bracelet. Use a strip of paper to make a binary code bracelet. Make a binary key ring.

Maze "Developing Resilience" Activity

Walking through a maze with verbal instructions develops resilience. This activity helps children listen to and follow instructions.

Objective:

Learners will be able to listen and follow directions as another person is verbally telling him/her which way to go to reach the end of the maze.

Materials:

Rope

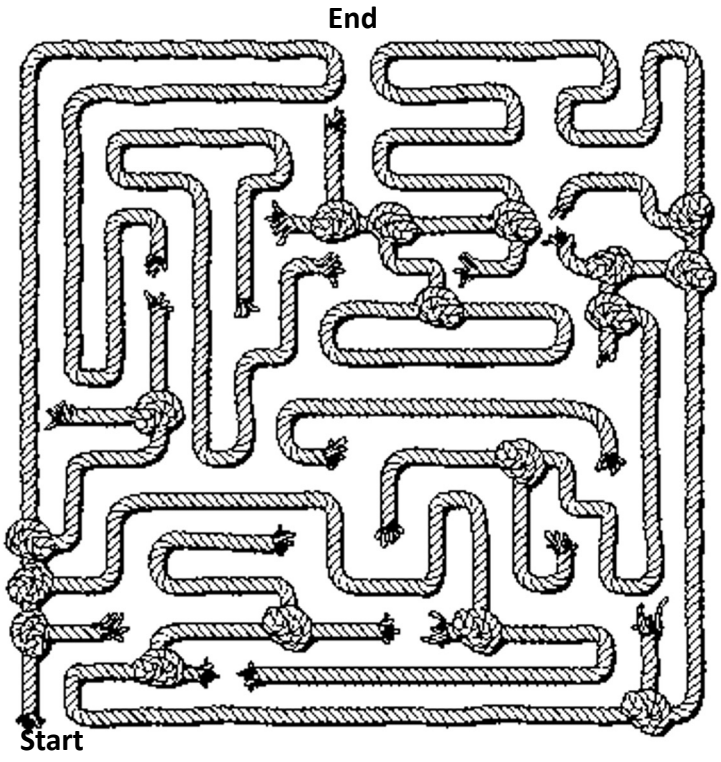
Blindfold (optional)

Instructions:

Have a student walk through the maze by listening to directions. Let the student know he/she will listen to verbal directions and slowly follow directions. **Child A** has his/her eyes closed and is only listening to instructions. **Child/Adult B** is giving instructions. Use Robot commands.

Robot Commands

- **Step Right**
- **Step Left**
- **Step Forward**
- **Step Backwards**



Variations: Have student create a maze with blocks. Student can close eyes and listen to directions.

Building Block "Debugging" Activity

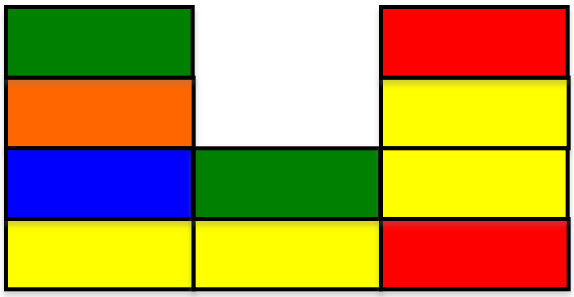
Building a block structure from a pattern or picture takes precise observation. Children are learning how to follow directions, patience, resilience and determination skills. These type of skills are needed by a computer programmer. Creativity when designing a building is a great skill in the development stage, however following verbal instruction is another. If the building structure does not look identical to the pattern and desired results have not been met, take the structure apart. Start over. This is called "Debugging" (removing errors) for computer programmers.

Objective:
Learners will be able to listen to directions to construct a block structure.

Materials: Blocks

Instructions: Give students verbal instructions on how to build a block structure.
Variations: Use color cubes. Set the cubes up in a specific code.

Pattern Example:



Nuts and Bolts of a Robot Activity

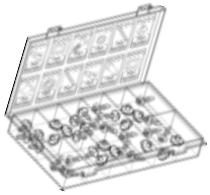
The purpose of this activity is for students to follow a pattern (pictorial directions) to construct a robot using cardboard pieces and nuts and bolts. Skills used for this activity include fine motor skills, sorting, matching, eye hand-coordination, debugging, math and language skills, and following visual directions.

Objective:

Learners will be able to construct a robot by following a pattern given a variety of nuts and bolts.

Preparation and Materials

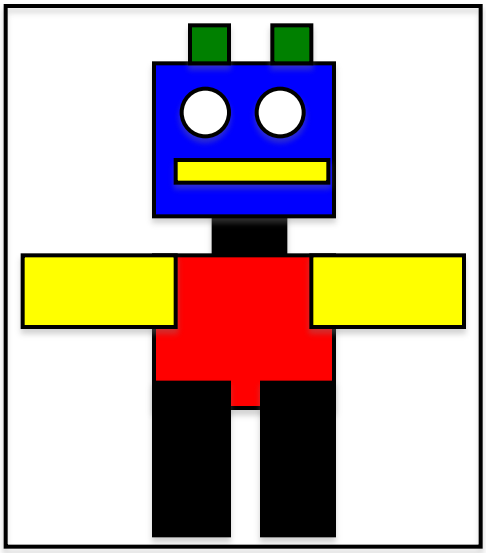
- Draw a simple pattern of a robot for students to follow
- Cut pieces of cardboard to match robot pattern.
- Pierce small holes in cardboard for screws to fit. The holes will be where cardboard pieces connect.
- Cardboard, variety of nuts, bolts, washers

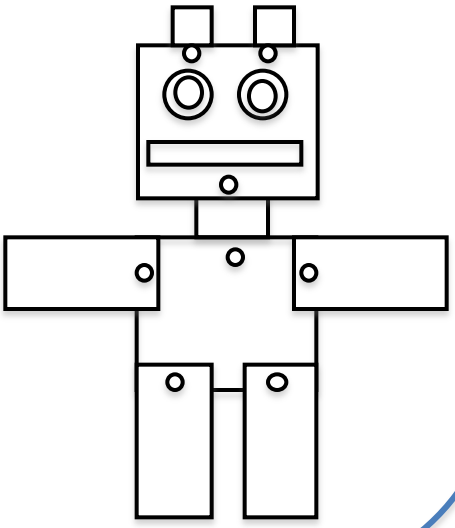


Instructions:

Place nuts, bolts, and washers in a container. Students will decide which nuts and bolts to use to build their robot. Provide students with precut cardboard and pattern of robot. The student will look at the pattern and put together the robot with nuts and bolts according to the pattern.

Variations: Color code cardboard pieces and give verbal directions to construct robot.





Build-a-Box Robot Activity

Building a box robot allows students to work as a team, design, use critical thinking skills, and creativity. Students will use their language, math and measuring skills to determine how tall to build their robot.

Objective:

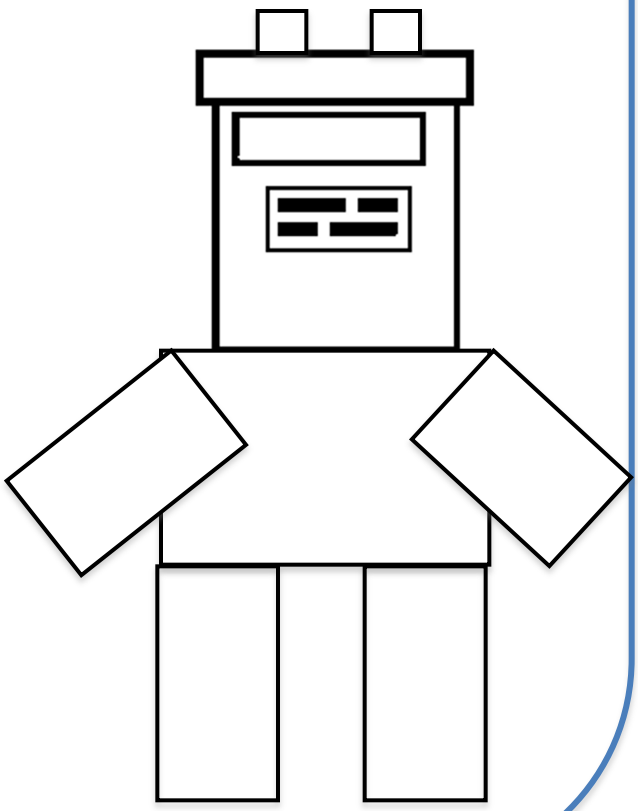
Students will be able to design a model of their robot in their journal and build the robot according to the model.

Materials:

- Variety of boxes (cereal boxes, mac and cheese boxes, etc.)
- Tape measure/Ruler
- Journal

Instructions:

Before students begin to build their robot, ask them to observe their material and sketch a model of the robot they would like to build. As a team, have students build their robot according to their design. Provide rulers and measuring tape so students can measure the height and width of the robot.



Loose Parts Robot Activity

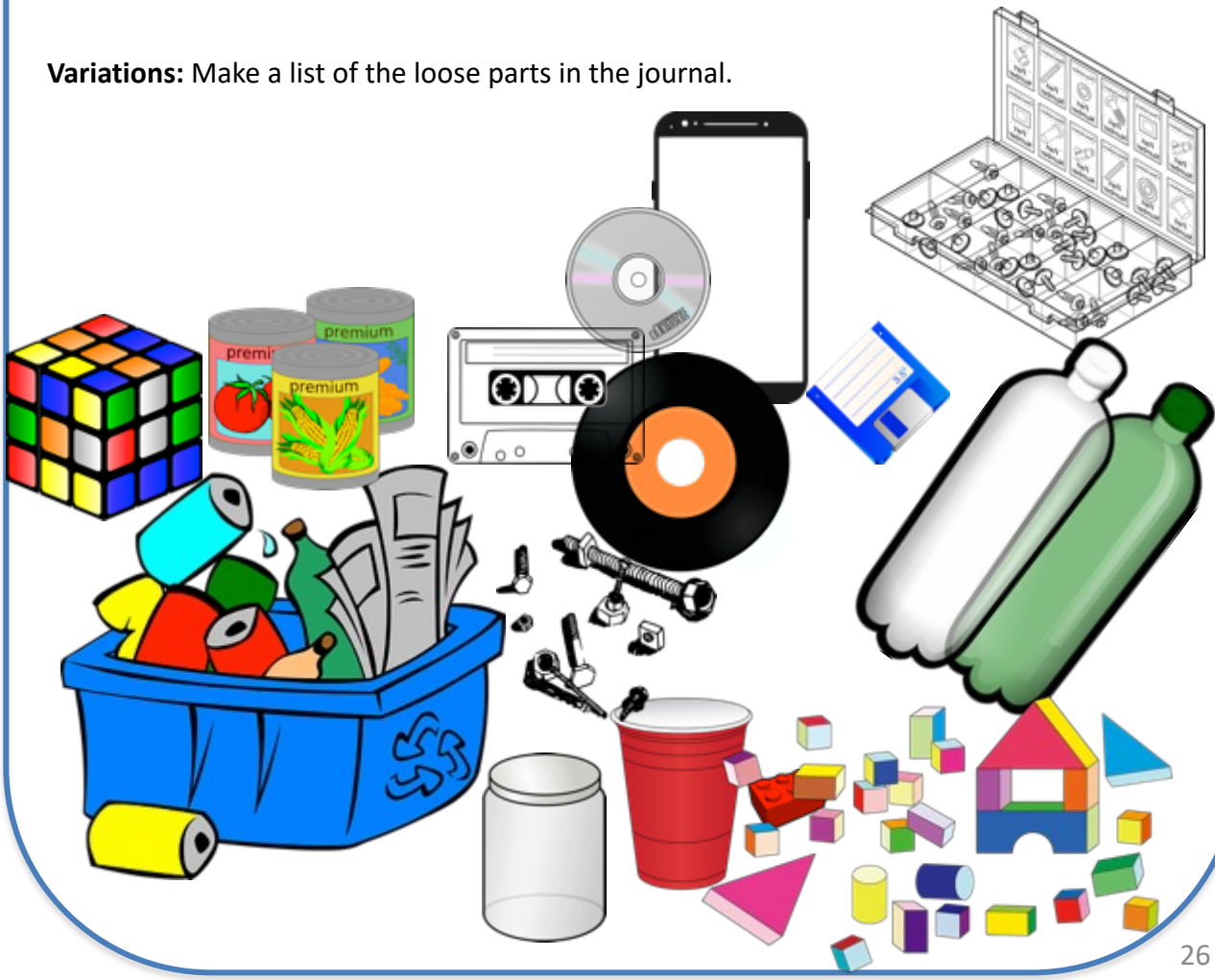
Students will be able to build a model of a robot with materials of their choice. Students will use critical thinking skills and creativity to build the robot.

Objective:
Learners will be able to design a robot using a variety of “loose parts”

Materials:
Recycled materials (Variety)
Journal

Instructions:
Set out a variety of material for children to use to design and build a robot. Have students work as a team. After the robot is built, ask students to tell you which items they used to build their robot.

Variations: Make a list of the loose parts in the journal.



Robotic Hand Activity

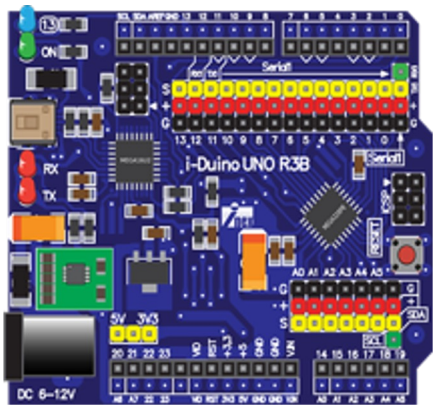
Teaching robotics gives students the opportunity to learn how science, engineering, math and technology interact and work together.

Objective:

Learners will be able to design a robotic hands by integrating science, engineering, math and technology.

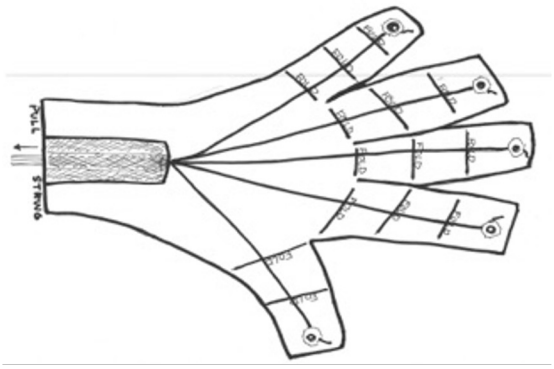
Materials:

- Cardboard or cardstock (Cereal box)
- Wide straw (2-3 inches long)
- Writing Utensil/Scissors/hole punch (1/4 inch)/ruler
- Wire/twine/Fishing line/Jute twine (either will work) (5 pieces 1/12 – 2 feet long)
- 5 small nuts and bolts (Screws)
- Duct tape



Instructions:

Prepare your materials before you begin. Trace your hand and wrist (about 2 inches from wrist) on a cardboard/cardstock paper. Cut the traced hand approximately ¼ inch outside of the line. Draw straight lines for finger joints on the cutout and fold and crease the lines. Hole punch the tip of each finger. Put bold through the hole punch and place the nut on the other side. Tie the string at the end of each fingertip before tightening bolt to screw. After the string is tied to each screw, tighten the bold down so the string is not loose. String the 5 pieces of string through the straw. Use the duct tape to tape the straw down to the cardboard just below the palm of the precut hand. Pull the string to made the robotic fingers move!



Variations: Use a different color string/wire for each finger. Use a journal to create and design a robotic spider. Draw a circuit board on outside of robotic hand.

Objective/s

3) Apply age appropriate coding and robotic strategies in everyday teaching strategies

Part 3: The Future of Robots

Introduction

According to new research, almost two thirds (60%) of British people believe there will be a robot in every home within the next 50 years. Modern robots have made their way to industries and into our homes. Although robots remain primarily in factories and labs, they have reached classrooms and have caught children's interests in the way of toys. Children are exposed to robots in many ways in the modern world, In animated movies, cars, and toy stores. Robots have made their way into schools through STEM based activities (Science, Technology, Engineering, and Mathematics). The STEM Education Coalition, based in Washington D.C., is to raise awareness and improve students skills for later success in the economic and technological global marketplace of the 21st century.

The research regarding STEM and early education is to break away from passive instruction and allow opportunities for critical thinking and investigation through play. The secret to teaching stem is to tap into children existing natural and innate curiously about the world around them. Encouraging children to ask questions is engaging them in STEM based activities.

Schools are rapidly adopting the implementation of STEM-based programs, primarily those including programming and coding instruction. By providing children with STEM skills, they are being provided with gaming options, tech skills and a way to bridge the gap between digital and the physical world. Bringing coding and robotics to the early learning sector promotes what children's natural curiosity is already doing!

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Resources

Free barcode generator - https://www.nicelabel.com/free-barcode-generator

Glossary of Terms

Algorithm – A process or set of rules followed in calculations or other problem-solving operations

Barcode – A pattern of parallel lines of varying widths, printed on and identifying a product.

Binary - A coding system using the binary digits and 1 to represent a letter, digit, or other character in a computer or other electronic device.

Coding – A code assigned for the purposes of classification or identification

Debugging – The process of identifying and removing errors from computer hardware or software.

Engineering – The branch of science and technology concerned with the design, building, and the use of engines, machines, and structures.

Loose Parts - In a play, loose parts are materials that can be moved, carried, combined, redesigned, lined up, and taken apart and put back together in multiple ways. They are materials with no specific set of directions that can be used alone or combined with other materials. Loose parts can be natural or synthetic.

Robotics – a branch of technology that deals with the design, construction, operation, and application of robots.